

## **PROGRAMMABLE AED-CPR TRAINING DEVICE**

### **Priority Claim**

[0001] This application is a divisional application of pending application 09/494,590 filed on January 31, 2000 which is currently pending and which claims priority to provisional patent application 60/117,727 filed on January 29, 1999.

### **Field of the Invention**

[0002] The present invention pertains generally to a training device used to assist a student operator in rescue procedures, and more particularly a hand-on training device used to assist a student in learning cardiopulmonary resuscitation (CPR), training instructions in the use of a defibrillator and rescue procedures such as rescue breathing and choking procedures.

### **Background of the Invention**

[0003] It has been estimated that over 350,000 deaths occur each year in the United States due to cardiac arrhythmia. Many of these deaths could be prevented by rescue procedures such as CPR and defibrillation by properly trained persons in rescue procedures. Thus, there is a continuing need to provide training to the public and to medical personnel in the proper treatment of a patient undergoing cardiac arrest or in need of rescue procedures. In order to train a student properly in rescue techniques, hands-on training aids such as manikins are often utilized. The disadvantage to prior art training aids is that separate devices are often needed to provide the full range of training. For example, CPR manikins and CPR prompting devices are used in training students CPR, while real defibrillator devices are used as defibrillator training aids. These devices can be quite costly. Further, the use of real defibrillator devices in a training environment creates a possible danger of discharging an unintended potent electric shock. Further, these type of devices in general only assist in the instruction of the use of the defibrillator, and do not provide instruction in the use of CPR or other rescue techniques such as rescue breathing. Still further yet, these training devices generally assume that the patient is of a sufficient age to receive shock treatment. In addition, prior art defibrillator and CPR training devices generally do not instruct the trainee to check for a pulse after a victim has received a shock treatment nor after a series of CPR compressions have been given. Finally, these type of training devices do not teach the proper placement of the paddles upon the patient.

[0004] These and other features and advantages of the invention will become apparent in the detailed description and claims to follow, taken in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a perspective view of a CPR-AED training device shown in use with a manikin according to the present invention;

[0006] FIG. 2 is a front view of the CPR-AED training device of FIG. 1 with the cover plate removed and the electrodes withdrawn.

[0007] FIG. 3 is a rear view of the CPR-AED training device of FIG. 1 with the programmable display panel in view.

[0008] FIG. 4 is a perspective view of a training electrode pad and cable shown with a removable attachment clip for insertion onto the training electrode pads.

[0009] FIG. 5 is an enlarged perspective view of the removable attachment clip shown in FIG. 4 which is shown installed on the training electrode pad.

[0010] FIG. 6 is a side view of the removable attachment clip shown in the direction 6-6 of FIG. 5.

[0011] FIG. 7 is an enlarged view of the removable attachment clip shown in the direction 7-7 of FIG. 6.

[0012] FIG. 8 is a bottom view of a training electrode pad with the target means shown in phantom in several locations.

[0013] FIG. 9 is a block diagram of the CPR-AED training device of FIG. 1.

[0014] FIGS. 10-12 are logic diagrams of the CPR-AED training device in the CPR ONLY Mode, the AED MODE, and the CPR-AED Mode.

[0015] FIGS. 13-15 are program control logic diagrams of the prompting sequences of the CPR-AED training device in CPR Mode, AED Mode, and CPR-AED Mode, respectively.

## DETAILED DESCRIPTION OF THE INVENTION

[0016] Mechanical system

[0017] Referring initially to FIGS. 1-3, a CPR-AED training device 10 of the present invention is shown. The device 10 prompts trainees with instructions on the proper sequence of steps of CPR and defibrillation in a non-emergency setting, with input information from the trainee to the device 10. With respect to the defibrillation prompting, the device 10 allows a trainee to evaluate simulated patient electrocardiogram (ECG) signals and perform simulated defibrillation with or without CPR prompting. As shown in FIG. 1, the device 10 may be used alone or in conjunction with a manikin 100 or other means for simulating a victim. The CPR-AED training device 10 comprises a body 12 having a front panel 14 and a rear panel 16, a cover plate 18, and carrying handle 20. The training device 10 further comprises an audio speaker 30 with volume control (not shown) for audibly prompting a trainee in rescue operations. The cover plate 18 is slidably mounted within grooves (not shown) of the body 12 of the training device and may be used to cover and protect the device CPR keypad 40. The CPR keypad 40 comprises a plurality of interactive key switches which are operative in the CPR mode 74 and are used by the trainee to provide feedback to the device 10 of the simulated victim's condition. The CPR keypad 40 includes an adult key 41, a baby key 42 and a child key 43 used by trainee to provide feedback to the device 10 of the victim's age. Additionally, the keypad 40 comprises a Heimlich maneuver labeled key "1" 44 used when victim is conscious and choking, and an abdominal thrust key "2" 45 utilized when the victim is unconscious with a blocked airway. Key "3" labeled Rescue breathing 46 is used when victim has a pulse but is unconscious, while key 4 47 labeled "CPR" is used when victim has been assessed by the trainee to be unconscious with no pulse or breathing. The CPR keypad 40 further comprises an off switch 48 which will switch off the device, and the pause key 49 which will pause the algorithm. The off switch is operative in all three modes, while the pause key is only active in both mode 76 and CPR mode 74. Finally,

each of the keys (except the off key) on keypad has its own LED indicator light to indicate when the key has been activated by the trainee.

[0018] The front panel **14** further comprises an AED keypad **50** comprising an AED POWER switch **52**, an ANALYZE switch **54**, and a SHOCK switch **56**. Each AED switch **52-56** has its own LED indicating light **58-62** to indicated that the switch has been activated when lit. In addition, the front panel of the device **10** further comprises a Select Prompting Mode switch **70** for allowing the trainee to select only defibrillation mode denoted as “AED” as mode **72** the CPR mode **74**, or both CPR and AED prompts denoted as “Both” **76**.

[0019] As shown in FIG. 3, the rear panel **16** of the device **10** comprises a power source **80** such as a battery pack and a Shock Sequence keypad **90**. The Shock Sequence keypad **90** is used by the trainee or instructor to program the sequences of shockable and non-shockable simulated heart rhythms when in the AED mode **72** or CPR-AED mode **76**, as explained in more detail below.

[0020] As shown in FIGS. 1 and 2, the front panel of the device **10** also comprises a plug receptacle **110** for receiving the plug end **112** of electrode cables **114**. The plug end **112** of the electrode cables has a built in jumper (not shown) in order to indicate continuity of the plug connection when it is properly installed within receptacle **110**. If not, trainee will be prompted to install the cable until the trainee has successfully plugged the electrode cable **114** into its receptacle **110-114**.

[0021] The opposite ends of the electrode cables **114** all connected to disposable electrode pads **120** via an electrode clip **140**. The disposable electrode pads **120** are simulated defibrillator pads and are to be inserted into the electrode clip **140** and then mounted by the trainee upon a simulated victim’s chest as explained in more detail, below. The electrode clip **140** as best shown in FIGS. 4-6, comprises two main components made of any suitable non-conductive material such as plastic. The first main component of the electrode clip **140** is the housing **142** which has a first and second mating member **144,146**, which together form a slot **148** for receiving an electrode training pad **120** therein. The first and second mating members **144,146** are connected together by a screw **150** or other connecting means. The second main component of the clip **140** is the securing means **160** which secures the electrode training pads

120 to the clip 140. The securing means 160 comprises a first and second arm 162 rotatably mounted to the clip housing 142, and a planar surface 164 with a tabular extension 166 for easy opening and closing of the clip securing means 160 to the housing 142. The inner surface of the tabular extension 166 has two spaced prongs 168 aligned for insertion into holes 169 of the first and second mating members 144,146 and holes 122 of the electrode pads 120.

[0022] Each electrode-training pad 120 is disposable and comprises an upper surface layer 122, a lower adhesive layer 124, and a conductive layer 126. The upper surface layer 122 of the training pad comprises a flexible plastic or foam material. The upper surface layer 122 of each training pad 120 is color coded with a graphic design 128 on the front surface layer 122 of the pads which illustrates the proper placement upon a victim's chest. The design further includes the number 1 or 2 that indicates the proper sequence of placement of the pads 120 upon the simulated victim's chest. The lower adhesive layer 124 of the electrode pads 120 has a removable protective liner 130 which is peeled away by the trainee prior to installation upon the simulated victim. The outer conductive layer 126 is adhered to the lower adhesive layer 124, and is formed of a thin plastic having a metallic or conductive substrate bonded thereto. The outer conductive layer 126 of each electrode training pad 120 acts as a built in sensor means which generates an output signal to the device 10 when the training pad is properly connected to the electrode clip 140 and placed in contact with a conductive target means 170. The conductive target means 170 is preferably an adhesive disc having an outer conductive layer such as metal. The conductive target means 170 are mounted upon a simulated victim's chest in the upper right chest and lower left rib position for defibrillation.

[0023] The sensor means 126 of the electrode training pad 120 as shown in FIG. 4 in phantom, has a first and second conductive path 132,134 respectively, with said second conductive path 134 preferably being located within the interior of said first conductive path 132, without touching said first conductive path 132. Preferably, each of said paths have an elongated rectangular shape, although other shapes would work for the invention. When the electrode pad 120 is received within the slot of the clip 160, the first and second conductive paths 132,134 of the conductive layer 126 contact a first and second conducting strip 136,138 mounted upon the interior surface of the first mounting member 144 of the clip housing 142. The first and second

conducting strip 136,138 is soldered to a first and second wire of the electrode cable 114 which has been inserted into the rear end of the clip housing 142.

[0024] Thus in order for the trainee to secure the removable electrode pads 120 to the clips 160, the holes 122 of the electrode training pad 120 are inserted through the slot 148 of the clip 160 such that the holes 122 and 169 are aligned. Then the clip securing means 160 is rotated into position such that the prongs 168 are inserted into the aligned holes 122 and 169, such that the first and second conducting strip 136,138 of the first mating member of the clip 160 contact with the conductive layer 126 of the electrode pads 120. After notched receiving end of the electrode pad 120 is inserted into the slot 148, the securing means 160 of the clip 140 is snapped into place such that the prongs 168 are inserted through holes 169 and 122 of the members and the electrode pad, respectively. When the trainee properly mounts each of the electrode pads within its clip 160 and properly places each electrode training pad 120 over its respective target means 170 on the simulated victim's chest, the target means 170 shorts or completes the circuit formed by the first and second conductive paths 132,134. When the circuit is closed, a small current is generated by the device 10 through the first conducting strip 136 and the first conductive path 132, through the target means 170 and then back to the device through the second conductive path 134 and the strip 138, thus indicating that the electrode training pad 120 has been properly placed upon the target 170. Each electrode training pad 120 must be properly placed over its conductive target 170, else the trainee will be continually prompted to "PLACE PADS ON VICTIMS BARE CHEST" until the operation is performed correctly for each pad 120. The trainee will continually be voice prompted until the sequence of operations has been correctly performed.

[0025] In an alternative embodiment of the invention, a reed switch is utilized as the sensing means in each disposable electrode pads. A reed switch may be attached to the outer surface layer of each electrode pad or mounted within the pad. The reed switch is used to sense when the pads are in close proximity to a target means having a magnet or magnetized surface. The target means are mounted in the proper area of a victim's chest for defibrillation. Alternatively, a magnet may be mounted upon the electrode pads and the reed switch mounted on the simulated victim's chest. When the reed switch is in close proximity to the target means,

the reed switch generates an electric signal which is communicated to the device **10**, and the trainee will no longer be prompted to “PLACE PADS ON VICTIM’S BARE CHEST”.

**[0026] ELECTRICAL SYSTEM**

**[0027]** There is shown in FIG. 9, a block diagram illustrating the logical arrangement of a system **200** according to the invention. The invention includes a first and second electronic input device, which is preferably keypads **18** and **50** or other keying means. The invention also includes multiple button switches and LED indicator lights. An energy source **210** such as battery pack provides power to the system. The training device further comprises a central processing unit **220**, memory **230** (RAM), and a speech synthesizer unit **240**. The speech synthesizer unit **240** further comprises an amplifier **250**, speaker **260**, a text to speech translator **270**, and a speech chip **280**. The speech chip **280** may comprise any chip which furnishes understandable speech suitable for use in the invention.

**[0028] OPERATION OF THE DEVICE**

**[0029]** In order to begin operation of the AED-CPR training device **10**, the trainee first selects the desired training mode using the Prompting Mode switch **70**. The AED-CPR training device **10** has three different training modes denoted as: “AED”, “BOTH”, and “CPR”. If the AED mode is selected, the training device **10** will only provide training prompts that simulate the operation of an actual defibrillator device. The device **10** will first simulate the collection of patient ECG data, then simulate the analyzing of the ECG data by the training device and then the delivery of a simulated electrical pulse to a simulated patient in response to actuation by the trainee. No actual electrical pulse is delivered. If the CPR mode is selected by the trainee, the training device **10** will provide detailed training prompts for the proper sequence of CPR rescue steps. If the “BOTH” mode is selected, the device **10** will provide the trainee with CPR and AED prompts. The operation of these three modes is described in more detail, below.

**[0030] AED MODE**

**[0031]** If the trainee selects the AED mode by setting the Prompting Mode switch **70** to the “AED” position, the CPR panel **40** is deactivated and the AED panel **50** is activated. The AED mode has three programmable modes for the ANALYZE key. The ANALYZE key may be

programmed using the Shock Sequence keypad **90** to toggle key **111** to simulate a manual defibrillator, a semi-automatic defibrillator or an automatic defibrillator. The programming steps are described in more detail, below.

[0032] As illustrated in FIGS. 12 & 13, the simulation of a manual defibrillator in AED mode **72** is described as follows. The trainee must press the “AED” switch **52** in order to begin. The trainee is then prompted by the device to place the training electrode pads **120** on the simulated victim’s bare chest, with pad “1” to be placed on victim’s upper right chest and pad “2” to be positioned on victim’s lower left ribs. If the training electrode pads are not placed on the simulated victim in the proper sequence, i.e., first training pad labeled “1” and then training pad labeled “2”, the trainee will be continually prompted until the trainee performs the operation in the required sequence. Further, each training electrode pad **120** must be placed such that each of its respective sensors **132, 134** contacts the respective conductive target **170** located on the simulated victim **100** or manikin. The trainee will continue to be prompted until the trainee successfully performs the sequence of operations. The trainee will then be prompted to connect the electrode plug **112** into the plug receptacle **110** of the device **10**. If the trainee performs this operation successfully, a jumper **111** located within the plug will complete the internal circuit. The device **10** senses that the plug **112** is installed when the jumper **111** completes the intended current.

[0033] After the training electrode pads **120** and the plug **110** of the electrode cable have been properly installed by the trainee, the trainee is prompted to press the “ANALYZE” switch **54** and to “STAND CLEAR” of the victim. The analyze LED **55** will flash on and off while the device simulates the Analyze function of a real defibrillator. The device **10** will have been previously programmed by an instructor or the trainee as described in more detail, below. The device will indicate to the user via voice prompting whether a shock is advised. If a shock is advised, the Analyze LED **55** will turn off and the shock LED light **62** will flash on and off, while the trainee is voice prompted “SHOCK ADVISED”. If a shock sequence is advised, the trainee will be prompted to “STAND CLEAR” of the victim while a simulated charging tone is emitted from the speaker. The trainee is prompted to “SHOUT ALL CLEAR” and to check if all clear and then press the “SHOCK” key **56**. When the “SHOCK” key **56** is pressed, the trainee will hear a simulated shock ready tone of approximately 15 seconds in duration and then a

simulated shock delivered tone. Then the Shock LED light **62** will be deactivated. The trainee will be prompted to press the ANALYZE key **54** to repeat the process. If no shock is advised, the Analyze LED **60** is turned off and the trainee is prompted to check the simulated victim's breathing and pulse. If no pulse is detected, the trainee is prompted to do CPR for a 1 minute interval. If no pulse is detected by the simulated defibrillator after the trainee has performed CPR for a set interval of time, the trainee is prompted to check the victim's pulse, and if no pulse is found, to press the Analyze key **54**.

[0034] The shock sequence as described above is programmable by the trainee or instructor using the shock sequence keypad **90** located on the rear panel. Thus the user may program the sequence of shock/no shock heart rhythms. Up to seven shock/no-shock sequences may be programmed. In order to program the device, the set key **92** is toggled on. Adjacent the set key **92** is seven toggle keys **93-99** labeled "1" through "7+", with each numbered key representing the numerical cycle of analyzed heart rhythms. Thus key "1" **93** represents the first cycle of simulated analyzed heart rhythms, key "2" **94** represents the second cycle of simulated analyzed heart rhythms, etc. Thus up to seven cycles may be programmed. In addition, each numerical key has its own LED indicator light **101** located immediately thereabove. The indicator light indicates (i.e., when lit) whether a shockable rhythm has been programmed. When the set key **92** is toggled on, the LED indicator lights **101** will light up if a shockable rhythm is desired for its respective numerical cycle. If the LED indicator light **101** is not lit, then the device will not recommend a shockable rhythm for that particular cycle. For example, if the American Heart Association recommended teaching shock sequence is : shock:shock:shock:no shock:shock:shock, then keys **1-3** and keys **5-7** will be toggled on such the their respective LED indicator lights **100** are lit. When finished programming, the set key **92** is toggled off.

[0035] The Shock Sequence Panel **90** also provides for turning on a "REFIBRILLATE" key **102**. To program the device for the REFIBRILLATE function, the set key **92** is toggled on and then the REFIBRILLATE key **102** is toggled on such that the LED indicator light **103** labeled "ON" lights up. The set key **92** is then toggled off. In order to use this feature, a non shockable rhythm must have been programmed. After the trainee receives the first "NO SHOCK ADVISED" prompt, the trainee will be instructed to "CHECK BREATHING AND PULSE", and "IF NO PULSE PERFORM CPR". The CPR interval will be interrupted to instruct the

trainee that the victim has went into a shockable rhythm. The trainee will be prompted to press the ANALYZE key. Thus when the REFIBRILLATE key is activated, a simulation of a non-shockable rhythm which converts into a shockable rhythm is demonstrated.

[0036] The Shock Sequence panel 90 also provides for the simulation of a manual, semi-automatic or automatic defibrillator by programming the Analyze key 111. The simulation of a semi-automatic defibrillator is the same as the manual defibrillator as described above, except the trainee is not prompted to press the Analyze key after it has been pressed once by the trainee. The simulation of an automatic defibrillator is the same as the above description, except the trainee is not prompted to press the ANALYZE key at anytime, as the device automatically goes into the simulated Analyze mode.

[0037] The Shock Sequence panel 90 also provides for the altering of the CPR prompting based upon the number of rescuers present for the CPR mode. After the set key 92 is toggled on, the "ADULT/CPR/TIME" key 106 may be set to either "1 Rescuer" 107 or "2 Rescuer" 108 mode. The timing of the CPR interval and the breathing rate will be affected. For 1 Rescuer attending a victim, the trainee will be prompted to do cycles of 5 chest compressions and 1 breath for 1 minute, while 2 Rescuers will be prompted to do cycles of 15 compressions and 2 breaths for 1 minute intervals. In addition, the Shock Sequence panel 90 also allows the trainee to program short or long prompting scripts for the rescue instructions for the AED, CPR or AED/CPR modes of operation by selecting the "PROMPTING FORMAT" key 109 and setting it to "short" or "long" formats. The "short" prompting format contains only the essential prompting queues, while "long" format gives trainee more detailed instructions. In addition, the Shock Sequence Panel 90 provides for programming the CPR interval, i.e., the time CPR is prompted, to 30, 60 or 90 second intervals.

[0038] **CPR MODE**

[0039] When the trainee manually sets the SELECT PROMPTING MODE switch 70 to CPR mode 74, the trainee will receive instructive prompts for performing CPR in conjunction with other rescue operations such as the HEIMLICH maneuver, abdominal thrusts and rescue breathing. In order to activate the device in this mode, the trainee must assess the victim's age and select the appropriate ADULT, BABY or CHILD key. As shown in FIGS. 10 and 13, the

trainee will be prompted to “REMAIN CALM; SHAKE VICTIM GENTLY AND SHOUT ARE YOU OKAY; IF NO RESPONSE CALL 911 NOW.” Next the trainee is prompted to “POSITION THE VICTIM ON HIS OR HER BACK ON A FIRM SURFACE.” and to “TILT HEAD; LIFT CHIN; CHECK BREATHING.” The trainee is then prompted to assess whether the victim is breathing. If the victim is not breathing, the trainee is instructed to “TILT HEAD LIFT CHIN; PINCH NOSE; BLOW; BLOW.” The trainee is then prompted to press pause key and repeat the above steps if no chest rise. The trainee will then be prompted to CHECK THE VICTIM’S PULSE. If a pulse is found but the victim is not breathing, the trainee is prompted to press Key 3 (Rescue Breathing). If no pulse is found, the trainee is instructed to press KEY 4 CPR. IF the victim’s airway is blocked, the trainee is prompted to press KEY 2 for abdominal thrust prompting.

**[0040]           CPR PLUS AED (BOTH) MODE**

**[0041]**       When the trainee manually sets the SELECT PROMPTING MODE switch to BOTH, the trainee will receive instructive prompts for performing CPR in conjunction with use of a defibrillator. The user may initiate this mode by pressing the ADULT key after assessing the victim’s age. If the BABY or CHILD key is pressed, the trainee will be prompted that he or she has pressed a wrong key, because infants or children are not recommended to receive defibrillation. After the ADULT key is selected, the trainee will be prompted as described above under the CPR mode. However, if no pulse is found, the trainee is instructed to press the AED power key 52 instead of the CPR key 4. The AED sequence of prompting is as described above under the AED ONLY section.

**[0042]**       While the preferred embodiments of the invention have been illustrated and described, it should be understood that variations will become apparent to those skilled in the art. Accordingly, the invention is not to be limited to the specific embodiments illustrated and described herein, but rather the true scope and spirit of the invention are to be determined by reference to the appended claims.